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ABSTRACT

This report covers the activities of the Knox County Mathematics Basic Skills Improvement Project from September 1980 to September 1982. The purpose of the project was to raise the level of student performance in the basic skill area of mathematics in the Knox County School System through the development of a restructured curriculum for grades kindergarten through 8 and to implement a viable program of instructional improvement, especially in those schools where student performance indicated the greatest degree of mathematics skill deficiency. Major areas discussed in the report include the project personnel and their work, inservice training, technical assistance, dissemination activities, and evaluation activities. A curriculum model, third grade mathematics curriculum, program brochure, and a paper by Charleen DeRidder and Donald J. Dessart ("Teaching: Using a Directed Lesson") are included in appendices. Results are provided for the achievement of students in experimental and control schools. These results indicate that the effect of the traveling mathematics teachers and the restructured curriculum had very positive effects as revealed by mean score gains. (JN)

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REPORT OF
THE KNOX COUNTY MATHEMATICS
BASIC SKILLS
IMPROVEMENT PROJECT

1980-82

EARL F. HOFFMEISTER, SUPERINTENDENT
SARAH SIMPSON, ACTING DIRECTOR OF INSTRUCTION

ACKNOWLEDGEMENTS

The work of this project is characterized by the participation and support of many people. The concept of using Traveling Mathematics Teachers was inspired by the Reading Resource Teacher Program of Virginia Underwood Kitts. Also the Reading Resource Teachers have met with the Traveling Mathematics Teachers to discuss areas of common concern. Many of the practical classroom ideas and suggestions utilized in the mathematics curriculum come from teachers all over Knox County. Sue Boyer has facilitated community awareness of this project through parent meetings within the schools. The elementary principals in both project and non-project schools have been most supportive and appreciative of the services provided. Mr. Bob Goff, Middle School Coordinator, helped design and develop the Pupil Progress Record Card. LaNoka Rhodes, Elementary School Coordinator, Willa Selvey and Anne Roney, Elementary Supervisors, have had a significant part in the project implementation. Both Sarah Simpson, Acting Director of Instruction, and Superintendent Earl F. Hoffmeister have expressed their faith and encouragement in the project work. Mr. Tom Schumpert, Assistant Superintendent, is to be commended for his patience and diligence in the management of project funds. Mr. James Robinson, Director of Federal Projects, has been a valuable resource person throughout the project duration. Dr. Sam Bratton, Supervisor for Research and Evaluation, has cooperated with us not only in the testing process but also in the evaluation work conducted by Dr. John Ray of the University of Tennessee. Dr. Charles Achilles, Martin McConnel, and Kevin Newman, also of the University of Tennessee, assisted in this work.

The technical assistance provided us by the personnel of the Frank Porter Graham Child Development Center of North Carolina and CEMREL of St. Louis, Missouri has been extremely helpful and welcome. The exceptional work of Dr. Gordon Benson, Educational Testing Service of Atlanta, Georgia, was one of many services provided by these organizations.

A special note of thanks is offered to Dr. E. Glenadine Gibb, noted mathematics educator and former president of the National Council of Teachers of Mathematics, for her participation and continued concern in support of the project work. Dr. Gibb is currently on the staff of the University of Texas at Austin

Acknowledgement should be given Charles Frazier of the staff of Channel 2 WSJK for his talented help in producing the video tape on the "Directed Mathematics Lesson" for inservicing teachers.

The major work of implementing this project and transforming it into an integral part of the Knox County instructional program has been accomplished by the Traveling Mathematics Teachers. Sandra Hamilton led the way in this role even before the project was realized. Her initial experience was most beneficial in guiding others in this work. Brenda Latham is to be recognized for her performance in preparing the "Directed Mathematics Lesson" video tape. The dedication and capable work of Sandra, Brenda, Kathy Arnold, Linda Fidler, Sue Isaac, and Emily Lenn have been the heart of this project.

Finally, we have been extremely fortunate to have had the guidance and expertise of Dr. Donald J. Dessart, Professor of Mathematics and Mathematics Education at U.T. Knoxville, as Project Advisor. His experience as a staff member of the National Science Foundation in Washington, D.C., provided valuable information for communication especially at the inception of the project. His professional background in mathematics education and research offered us a resource without parallel in the development of the mathematics curriculum.

He is also the author of this project report. We are extremely grateful to have had a person of his stature and dedication in the field of mathematics education as a member of the project staff.

Charleen DeRidder
Director

Preface

The teaching of mathematics and particularly computational skills are important to the welfare of the individual as well as to the progress of society. The Knox County Mathematics Basic Skills Improvement Project attempted to identify a problem; that is, the lack of computational skill development in a set of Knox County Schools and then preceeded to solve that problem. Superintendent Earl F. Hoffmeister commented in this way:

"We are very happy that the U.S. Department of Education chose to support our inschool project to raise the level of basic computational skills in mathematics, and I am particularly pleased that this project went 'beyond the basic skills' by emphasizing problem solving. After all, computational skills are merely tools to solve problems; there is little sense in owning a hammer, if you can't drive a nail!"

The project is not only a means of improving mathematics teaching in Knox County but also serves as a model for other schools. The restructured curriculum and the concept of the traveling mathematics teachers are valuable features that proved very worthwhile.

Sarah Simpson, Acting Director of Instruction, wrote:

"The Knox County Mathematics Basic Skills Improvement Project with its new curriculum emphasizing problem solving as well as computational skills has been an important addition to our program. It is my hope that it will be a means of improving the teaching of mathematics in Knox County as well as serving as a model for other school systems."

Better education is the goal of the Knox County Schools for all of their children. The Mathematics Basic Skills Improvement Project is one facet of that program.

THE KNOX COUNTY MATHEMATICS

BASIC SKILLS IMPROVEMENT

PROJECT

Staff: 1980-82

Director:	Charleen M. DeRidder
Traveling Mathematics Teachers	Kathy H. Arnold* Linda W. Fidler Sandra Hamilton Sue Isaac Brenda C. Latham Emily Lenn**
Project Advisor	Donald J. Dessart
Evaluation Group	Gordon Benson Samuel Bratton John R. Ray Kevin Newman

* 1980-81
** 1981-82

TABLE OF CONTENTS

		Page
I.	Introduction	1
	Purpose of the Project	1
	Curriculum Development	1
	Instructional Improvement	3
II.	Project Personnel and their Work	3
	The Director	3
	The Traveling Mathematics Teachers	5
	The Project Advisor	6
	The Evaluation Team	7
III.	Inservice Training	8
	Orientation of Principals and Staff	8
	Training of the Traveling Mathematics Teachers	9
	Training of Teachers	11
IV.	Technical Assistance	14
V.	Dissemination	15
	Activities with Outside Systems	16
	Professional Associations	16
	Publications	17
VI.	Evaluation	18
	Evaluation Design	18
	Results	20
	Discussion	27
	Comments from Principals	28
VII.	Appendices	
	Appendix A Curricular Model	34
	Appendix B Sample Curricular Material	38
	Appendix C Program Brochure	48
	Appendix D Teaching: Using a Directed Lesson	50

LIST OF TABLES

Table		Page
I	Comparison of Experimental-Experimental (EE) Schools of Knox County with Matched Schools of Control Groups with Pre-Test Given in Spring, 1981 and Post-Test in Spring, 1982.	22
II	Comparison of Control-Control (CC) Schools of Knox County with Matched Schools of Control Groups with Pre-Test Given in Spring, 1981 and Post-Test in Spring, 1982.	25
III	Comparison of Control-Experimental (CE) Schools of Knox County with Matched Schools of Control Groups with Pre-Test Given in Spring, 1981 and Post-Test in Spring, 1982.	27

I. INTRODUCTION

The Knox County Mathematics Basic Skills Improvement Project was supported by the U.S. Department of Education for a period of two years, September, 1980 to September, 1982. This report covers the activities of the project for that two-year period. The original grant was to fund the project for a four-year period, but changes in the political climate in Washington and the move away from individual to block grants curtailed the final two years. The project conducted both curricular and instructional improvement components during the 1980-82 period.

Purpose of the Project

The overall purpose of the project was (1) to raise the level of student performance in the basic skill area of mathematics in the Knox County School System through the development of a restructured curriculum for grades kindergarten through 8 and (2) to implement a viable program of instructional improvement especially in those schools where the student performance indicated the greatest degree of mathematics skill deficiency. It should be understood that "basic skills in mathematics" with respect to this project meant not only minimal computational skills, but also problem-solving skills and areas of concept development emphasized by leading national and international mathematics education organizations (NCTM, NCSM, ICME) as necessary for a sound, comprehensive mathematics curriculum.

Curriculum Development

The curriculum development component consisted of restructuring the Knox County Curriculum in mathematics for grades K through 8 so that two considerations were given emphasis: (a) attention to more effective instruction of arithmetic skills and (b) curricular emphasis for a comprehensive program,

not restricted only to arithmetic skills, as recommended by national and international mathematical education organizations. This would insure that the Knox County curriculum would not merely attempt to include the so-called "basic skills" in mathematics, but would also go "beyond the basics" to such important learning outcomes as problem solving and critical thinking.

The organization of the curriculum can be viewed as three dimensional. First of all, there was the statement of specific skills and concepts to be mastered by students (behavioral objectives). Based on the Knox County mathematics goals and objectives, these skills and concepts included but were not limited to the Tennessee State Proficiency Objectives. Enrichment skills were included for all students and advanced skills were included for those students who are more mathematically mature. A unit format, which clusters related skills and concepts, was used for all grades except kindergarten.

Secondly, suggested teaching strategies and learning activities (process objectives) were provided to correspond with the unit skills and concepts for classroom implementation. These strategies and activities had been prepared to reflect the basic skill areas identified by the National Council of Supervisors of Mathematics. The implication was that these process objectives should permeate the teaching/learning activities.

The third dimension of this model was that of assessing student achievement and learning. In constructing the diagnostic/achievement (d/a) inventories for each unit, the attempt was made to test for the levels of cognition derived from the assessment matrix used by the 1978 National Assessment of Educational Progress, i.e., mathematical knowledge, mathematical skill, mathematical understanding and mathematical application (product objectives). This was true also of the cumulative achievement inventories prepared for

grade levels 1-8. Inherent in the unit d/a inventories was a format which assessed mastery of each skill/concept contained within a given unit.

Instructional Improvement

The instructional improvement component of the project consisted of the work of five traveling mathematics teachers, inservice sessions for teachers, and longer, special courses for teachers. The actual tasks of the traveling mathematics teachers will be discussed later in this report, but their primary task was to visit schools of greatest need, identified as target schools, for the purpose of assisting teachers with improving their instructional techniques as well as with implementing the restructured curriculum.

In addition to the work of the traveling mathematics teachers, inservice sessions included "make-it-take-it" sessions in which teachers had opportunities to make instructional materials which they could later use in their classroom instruction. A longer, college credit course entitled "Beyond the Basics in Mathematics Education" was offered through the University of Tennessee for selected teachers from the target schools.

II. PROJECT PERSONNEL AND THEIR WORK

The Director

The Director of the project was Charleen M. DeRidder, also the Supervisor of Mathematics for the Knox County Public School System. Her responsibilities included the overall coordination and planning of the project which involved the selection and training of personnel, coordination of the project with principals of the target schools, the chairing of the Friday planning meetings attended by the traveling mathematics teachers and frequently by the project advisor, planning of inservice sessions for teachers, maintaining a liaison with officials of the U.S. Department of Education in Washington, D.C., supervising expenditures from the grant, and implementing the evaluation of the project.

A more explicit delineation of the responsibilities of the project director are given below:

1. To organize and manage the development of the mathematics curriculum and the diagnostic/achievement inventories,
2. To meet weekly with the traveling mathematics teachers to confer on the work being done, to assess needs to be addressed by inservice sessions, to keep informed of the adequacy of the curriculum being field-tested,
3. To arrange for consultant help from the University of Tennessee Department of Mathematics and Curriculum and Instruction (or other qualified persons) to attend certain project staff weekly conferences,
4. To organize and identify leaders for the inservice sessions to be conducted for teachers,
5. To be responsible for the selection and requisition of all program curriculum materials,
6. To coordinate and lend assistance to the outside evaluator,
7. To consult with the elementary supervisory staff to coordinate the activities of the traveling mathematics teachers with other elementary programs,
8. To keep the Director of Instruction informed as to the progress of the project,
9. To meet periodically with the administrative staff Program Coordinating Committee to insure and maintain effective coordination and interaction of the various programs in operation in the Knox County School System,
10. To make occasional on-site visits to the target schools to directly monitor the work of the project,

11. To keep informed of curricular recommendations and instructional strategies advocated by the professional mathematics education organizations and studies conducted by the Federal government,
12. To maintain liaison with the Tennessee State Department of Education concerning the progress of the project,
13. To oversee the implementation of the total project to achieve the stated objectives.

The Traveling Mathematics Teachers

The five traveling mathematics teachers for the academic year of 1980-81 were: Kathy H. Arnold, Linda W. Fidler, Sandra C. Hamilton, Sue Isaac, and Brenda C. Latham. This group continued during the 1981-82 academic year with the exception of Kathy Arnold who returned to the classroom and was replaced by Emily Lenn.

Each of the traveling mathematics teachers served about four schools each year so that each spent about one day per week at each of the schools. They were available to assist and work with teachers in varieties of ways. These may be classified as program implementation activities and support activities. Program implementation activities, as the name implies, were designed to provide direct assistance to teachers in utilizing the mathematics program more effectively in the schools; whereas, support activities were help that would free teachers to spend greater amounts of time on program implementation. These activities are listed below.

Program Implementation Activities

1. Curriculum clarification for an individual or group which also included explanation of instructional procedures for implementation.

2. Teacher inservices included "individual instruction" to a teacher such as explaining testing process, student grouping, record keeping and "workshops" related to the curriculum implementation.
3. Planning with a teacher for some activity to take place with students which included planning for demonstrations, modeling, testing, etc.
4. Teaching included demonstration lessons, tutoring team presentations and other activities where the traveling teacher provided direct instruction to a student or several students.
5. Materials workshops were conducted for parents, aides, volunteers and others.

Support Activities

1. Typing, laminating, dittoing, making games, and making products for teacher use.
2. Ordering materials, delivering materials, responding to materials requests.
3. Scheduling teacher visits, arranging for parent workshops, arranging or preparing teacher inservice.
4. Interaction with administrators: principals, central office, staff meetings.
5. Conducting individual student placement testing.
6. Curriculum rewriting as a result of teacher feedback from field testing of the material.

The Project Advisor

The Project Advisor was Dr. Donald J. Dessart, Professor of Mathematics and Mathematics Education at The University of Tennessee, Knoxville. The

project advisor was available for about 3-4 days per month for consultations with the director about problems related to program implementation, curricular design, relationships of the project to federal policies (the project advisor had spent a year with the National Science Foundation in Washington, D.C.), and other problems for which the advisor could be of assistance. The project advisor attended many of the Friday planning meetings and offered advice and assistance. He also advised in regard to the evaluation design and implementation, and during the Fall of 1981 conducted an inservice course. "Beyond The Basics in Mathematics Education", for 25 teachers selected from the target schools. This course will be described more fully later in this report.

The Evaluation Team

The Evaluation Team was headed by Dr. John R. Ray of The University of Tennessee, Knoxville. Dr. Sam Bratton was the Knox County Public Schools representative to the team, and Dr. Gordon Benson of the Educational Testing Service in Atlanta was a consultant. The team was also assisted by a number of graduate students from The University of Tennessee, Knoxville.

The initial plan for the evaluation was to cover a four-year period, the original length of the project. The evaluation was altered to fit a two-year model for the project. Quite naturally, results were expected to occur over a four-year period because of the developmental nature of the project. Truncating the project to two years made a true assessment of its effectiveness impossible. These results will be discussed more completely in the evaluation section of this report (see Section VI, Evaluation).

Briefly, in the evaluation the Knox County project schools were compared with schools outside of the county. The project schools were also visited by members of the Evaluation Team (John Ray, Martin O'Connel and graduate students) to assess the degree to which the activities of the project were implemented

in the schools. All of these aspects are discussed in Section VI.

III. INSERVICE TRAINING

The inservice training conducted by the Project consisted of orientation sessions for the principals and staff, training of the Traveling Mathematics Teachers, inservice sessions for the teachers, and a college course for project teachers.

Orientation of Principals and Staff

At the beginning of the Project during the Fall of 1980, the director and the project advisor reported to the principals the purposes of the project and its general philosophy, the organization and workings of the project, particularly the role of the traveling mathematics teachers. This reporting was done in connection with the regularly scheduled pre-school meeting for elementary principals.

Again in mid-year, January 19-20, 1981, the director and the project advisor reported again to the principals at the Administrator's Conference concerning the progress of the project and also obtained reactions from the principals. The reactions were most favorable especially related to the work of the traveling mathematics teachers.

The two sessions discussed above represented a formal means of orienting the principals. The traveling mathematics teachers performed an informal orientation by meeting with the principals at the beginning of each school year. Throughout the year additional conferences were held to keep the principals informed of project work. These conferences were always maintained at a level related to the work of the project and purposely avoided any evaluatory discussions of individual teachers. Such a stance was absolutely necessary in order to maintain the confidence of the classroom teachers.

Training of the Traveling Mathematics Teachers

The traveling mathematics teachers were selected based upon their successes as classroom teachers in addition to their personal characteristics which would enable them to work well with teachers. The traveling mathematics teachers filled the roles of "motivators" and "facilitators" and not that of "supervisors". This was an important distinction that was emphasized throughout their training. The orientation of the traveling mathematics teachers began with a week long session of discussions related to their work and responsibilities. Included in this orientation was the opportunity to interact with the traveling reading teachers who were predecessors in this type of role in the Knox County School System. Such topics as their relationships with teachers, principals, and other supervisory staff were emphasized. The ways in which the traveling mathematics teachers could assist teachers were discussed in length. A "soft-sell" approach was adopted in order to establish a strong foundation upon which later teacher relationships could be built. The traveling mathematics teachers always maintained the role of helping colleagues as an added staff member. This was as important posture to maintain in order to achieve acceptance in the school and the individual classrooms.

Each Friday morning for nearly the entire life of the Project, the traveling mathematics teachers met with the director and frequently the project advisor. The sessions usually covered such topics as developing the restructured curriculum, planning for inservice sessions, discussion of schedules of work in the classroom, and other topics of an administrative nature. A more important part of the session was devoted to each traveling mathematics teacher reporting upon the activities of the week and especially upon any special problems that arose. Such problems were often times discussed at length and with the help of the director, closure was obtained for each problem; that is,

an agreed upon course of action was pursued. On occasion, these Friday sessions were attended by visitors (i.e., Doris Crudup, the program officer from the U.S. Department of Education; Glenadine Gibb, a special consultant from the University of Texas; LaNoka Rhodes, Elementary School Coordinator and the elementary supervisors, Willa Selvey and Anne Roney.)

In addition to the "in-house" type of training sessions that were held, the traveling mathematics teachers also attend meetings of professional associations. The meetings which were attended and their dates are listed below:

Meeting	Place	Dates	Attended By
TMTA Calculator Conference	Nashville, Tennessee	March 19-21, 1981	Linda Fidler
NCTM Annual Meeting	St. Louis, Missouri	April 22-24, 1981	All Traveling Mathematics Teachers
Houghton-Mifflin Mathematics Conference	Evanston, Illinois	July 21-22, 1981	Brenda Latham
NCTM Regional Meeting	Atlanta, Georgia	March 4-6, 1982	All Traveling Mathematics Teachers
TMTA Annual Meeting	Cookeville, Tennessee	May 7, 1982	All Traveling Mathematics Teachers
ACEI Regional Conference	Knoxville, Tennessee	July 29-30, 1982	Emily Lenn

In addition, the traveling mathematics teachers attended and were on the program of numerous meetings of the Smoky Mountain Mathematics Educators' Association (SM^2EA) on November 17, 1980; March 9, October 5, 1981; March 15, May 17, 1982 and ETEA Meetings on October 31, 1980 and October 30, 1981.

Two of the traveling mathematics teachers attended special conferences of CEMREL, Inc. In June, 1981 Brenda Latham attended such a conference in Nashville, Tennessee on the topic of project implementation and in May, 1982,

Sandra Hamilton participated in a conference at Savannah, Georgia concerned with dissemination of project materials.

Technical assistance conferences were conducted by the Frank Porter Graham Child Development Center of The University of North Carolina; CEMREL, Inc. of St. Louis, Missouri; and The Network, Inc. of Andover, Massachusetts. These conferences were designed to provide more technical types of assistance than were available elsewhere.

Training of Teachers

The training of the teachers consisted of orientation sessions concerning the project conducted by the traveling mathematics teachers and the director, special sessions provided by outside consultants, and a special course for selected teachers given by the project advisor.

The traveling mathematics teachers conducted numerous inservice sessions, "make-it-take-it" workshops, and other types of training sessions. In order to give an idea of the variety of sessions that were conducted, a listing is given on the following page of titles and dates of presentation.

TMT Conducted Inservice Sessions

Date	Meeting
September 1, 1981	Ramsey Faculty Meeting
September 3, 1981	Inservice for teachers at Young Dev. Center
September 9, 1981	Corryton, S.A.C.
September 10, 1981	Ramsey S.A.C. East Knox Faculty
September 11, 1981	East Knox S.A.C.
September 12, 1981	Sunnyview S.A.C.
September 16, 1981	Ritta S.A.C.
September 29, 1981	Ramsey P.T.O.
October 5, 1981	Workshop for SM^2EA
October 13, 1981	Ritta-Open House
November 11, 1981	Middle School Curriculum Meeting
December 26, 1982	Textbook Committee
March 15, 1982	SM^2EA Conference
March 19, 1982	Inservice U.T.K.
March 29, 1982	Inservice, Ritta, East Knox
April 27, 1982	Parent Workshop at East Knox
May 17, 1982	Inservice Ramsey
May 25, 1982	Textbook Inservice
June 3, 1982	Project Inservice with Gordon Benson
July 12, 1982	Inservice Session at Savannah, TN

The traveling mathematics teachers also cooperated with the Teacher Center in Knoxville by presenting special sessions. These are listed below:

Date	Participants and Topics
October 20-23, 1980	All project schools attended
February 26, 1981	Sandra Hamilton-geometry-all traveling mathematics teachers assisted
April 29, 1982	Sandra Hamilton-measurement-all traveling mathematics teachers assisted
January 21, 1982	Linda Fidler-place value-all traveling mathematics teachers assisted

The numerous sessions listed above were supplemented by work of outside consultants. On October 15-16, 1980, E. Glenadine Gibb, Professor of Mathematics Education at The University of Texas at Austin and a former President of the National Council of Teachers of Mathematics visited with the teachers and staff. On October 16th, she presented a session which was open to all teachers in Knox County. Her topic dealt with general problems related to computation. The next day she conducted a work session for the traveling mathematics teachers and the elementary supervisors.

Dr. Gibb returned to Knox County in early February, 1981 during which she conducted several sessions for project teachers and others. Dr. Gordon Benson of ETS visited the schools on several occasions as an evaluation consultant, but during May of 1982 he worked with project teachers in formulating precise type objectives for evaluation purposes.

During the Fall of 1981, Dr. Donald J. Dessart, the Project Advisor, offered a special course for selected project teachers. This course offered for university graduate credit in the Department of Curriculum and Instruction was entitled, "Beyond the Basics in Mathematics Education". The course objectives are listed below:

1. To acquaint the student with problem solving as a necessary ingredient to skill development in mathematics education.
2. To provide the student opportunities to employ the Polya Model of problem solving, which involves, "understanding the problem", "devising a plan", "carrying out the plan", and "looking back".
3. To provide opportunities to develop and employ heuristics (activities that stimulate problem solving.)
4. To appreciate better the importance of certain mathematical concepts and principles in the history of human endeavor.
5. To view mathematics as a study that includes and goes beyond the

development of computational skills.

The participants of the course were:

Sally N. Bodenheimer
Sandra R. Bonds
Martha A. Boney
Marilyn Brock
Betty J. Crabtree
Patricia A. Ely
Patti A. Haun
Anne A. Hawkins
Margaret J. Hughett
Elizabeth A. Mahoney
Georgia A. McDaniel
Bill J. McElhaney
Candace C. McKinney
Pamela V. Mynatt
Jennifer N. Pollard
Shirley J. Reeves
Janice E. Robertson
Sherry S. Roberts
Loretta H. Seay
Carolyn R. Sharp
Margaret S. Stallings
Sherry C. Vaughn
Hugh Wells
Katrinka A. Williams
Jane Yarbrough

IV. TECHNICAL ASSISTANCE

The U.S. Department of Education provided technical assistance, that is, a type of assistance which would not be readily available elsewhere. Projects in the Southeast were served by The Frank Porter Graham Child Development Center of The University of North Carolina and CEMREL, Inc. of St. Louis, Missouri. This technical assistance proved to be a valuable aspect of the Project's activities.

During 1980-81, activities sponsored by the U.S. Department of Education and also those by the technical assistance agencies are given below by dates:

1. September 21-24: National Basic Skills Orientation, Washington, D.C. Conference attended by the project director and the project advisor.

2. December 8-9: Regional Technical Assistance Meeting, Chapel Hill, North Carolina; attended by the project director and Dr. Charles Achilles of The University of Tennessee, Knoxville.
3. January 25-27: Evaluation Conference, Jacksonville, Florida; attended by project director and the project advisor.
4. February 10: Gloria Honda of The Frank Porter Center visited with the project to finalize the technical assistance agreements for evaluation of the project work.
5. March 16: Dr. Gordon Benson worked with Dr. John Ray, Dr. Sam Bratton and the staff designing an evaluation model.
6. June 17-19: Southeast Regional Workshop on Project Implementation, Nashville, TN attended by Brenda Latham.

During 1981-82, the activities were as follows:

1. October 25-28: National Basic Skills Conference, Washington, D.C., attended by the Project Director and Project Advisor.
2. January 27-29: Southeast Regional Workshop on Evaluation, Atlanta, Georgia, attended by Dr. John Ray and Dr. Sam Bratton.
3. May 10-12: Southeast Regional Workshop on Project Dissemination, Savannah, Ga. attended by Sandra Hamilton and the Project Director.
4. August 30-September 1: Concerns-Based Consulting Skills Workshop, Andover, Ma. attended by the Project Director.

V. DISSEMINATION

Dissemination of the concept of the project was not a major task of the Knox County Mathematics Basic Skills Improvement Program for the year 1980-1982. If the project had run its full four year's of work, if the evaluation had been over a longer period of time, and if the project had been accepted by the Joint Dissemination Review Panel (JDRP), then dissemination would have been a major

focus of the project. In fact, the years after 1984-85 would have been devoted largely to disseminating the features of this project as a model project.

In spite of these conditions, there was a reasonable beginning of dissemination efforts during 1980-82. These included talks and inservice sessions with other school systems, the distribution of curricular materials (see Appendix--for samples), talks at meetings of professional associations, some television exposure and publications, including a brochure (Appendix C), an article in The Arithmetic Teacher (Appendix D); and this report, which serves as a dissemination vehicle as well as a final report.

Activities with Outside Systems

On occasion, other systems have inquired about the workings of the project. When possible curricular materials and a brochure were sent to them, on other occasions, members of the staff presented talks. These talks are listed below:

Date	Place	Speaker
August 17, 1981	Lenoir City	Project Advisor
August 17, 1981	Cleveland	Project Director
August 17, 1981	Campbell County	Traveling Mathematics Teachers
March 12, 1982	Sumner County	Project Director
July 12, 1982	Hardin County	Sandra Hamilton and Brenda Latham

Professional Associations

Since the members of the staff are members of professional associations, ample opportunities were had for talks at meetings of the associations. These sessions with dates and places are listed below:

Date	Association	Place	Speaker
August 10, 1980	ICME	Berkley, CA.	Project Advisor

Date	Association	Place	Speaker
November 13, 1980	MAIS	Nashville, TN	Project Advisor
November 21, 1980	NCTM	Washington, D.C.	Project Advisor
April 24, 1981	NCTM	St. Louis, MO	Project Advisor
March 20, 1981	East TN Supervisors' Educ. Conference	Knoxville, TN	Project Director, Project Advisor
July 17, 1981	TASCD	Gatlinburg, TN	Project Director, Project Advisor
September 25, 1981	NCTM	Lexington, KY	Project Director
February 13, 1982	TASCD	Memphis, TN	Project Director Project Advisor
March 18, 19, 1982	East TN Educ. Conference	Knoxville, TN	Project Director Project Advisor
July 20, 1982	Tennessee Association of Middle Schools	Gatlinburg, TN	Project Director Project Advisor

Television

Although opportunities for dissemination of the project's work on television were limited, the staff participated in the development of a video tape entitled the Directed Mathematics Lesson, which is a means of teaching basic skills at the elementary levels. Mrs. Charleen DeRidder and Mrs. Brenda Latham had major roles in the tape which demonstrated the steps of a directed mathematics lesson with a small group of Knoxville fourth graders. The tape was later shown several times over public television and also became part of the training efforts of the state's Basic Skills First Program.

Publications

The publication program was not extensive, but it did represent a beginning. At the end of the first year of the project, a brochure (See Appendix C) was prepared. This brochure pictorially described the Project's

purpose, program, schools served and principals' names, and the names of members of the project staff. Approximately 7000 brochures were printed and distributed to schools, audiences at professional meetings, and in varities of other ways.

The Directed Mathematics Lesson with its five steps of introducing, presenting, analyzing, practicing, and applying became the subject of an article entitled "Teaching: Using a Directed Lesson" by the Project Director and the Project Advisor. This article appeared in the November, 1982 issue of The Arithmetic Teacher, an official journal of the National Council of Teachers of Mathematics. This article received national distribution and will reflect the authors' efforts to provide a teaching model for basic skills (Appendix D).

VI. EVALUATION

The initial evaluation design that had been planned for a four-year project had to be abandoned in favor of a two-year design because of the changes from individual to block grants in the federal policies dictated to the U.S. Department of Education. Quite naturally, a two-year design could not reveal the same results as a four-year design particularly in light of changes that occurred in testing policies in the Knox County School System, i.e., the County changed from using the Metropolitan Achievement Tests during 1979-80 to the California Achievement Tests during 1980-81. Consequently only one year of data on the California Achievement Tests was available, namely, the changes from the spring testing of 1981 to the spring testing of 1982. In spite of that limitation, some interesting results were found.

Evaluation Design

In March of 1981, the evaluation group composed of Dr. John Ray and Dr. Sam Bratton with consultant Dr. Gordon Benson of ETS, assisted by the

Director and the Project Advisor agreed upon an evaluation design that would organize the schools into four distinct groups as indicated below:

EE: Experimental schools during both 1980-81 and 1981-82, (These schools used the Knox County Curriculum both years and had the services of the traveling mathematics teachers during both years.)

CC: Control schools during both 1980-81 and 1981-82. (These schools used the Knox County Curriculum both years but did not have the services of the traveling mathematics teachers during either year.)

CE: Control schools during 1980-81 and experimental schools during 1981-82. (These schools used the Knox County Curriculum both years, did not have the services of a traveling mathematics teacher during 1980-81, but did have the service os such a teacher during 1981-82).

EC: Experimental Schools during 1980-81 and control schools during 1981-82. (These schools used the Knox County Curriculum both years, had the services of a traveling mathematics teacher during 1980-81, but did not have these services during 1981-82).

The Knox County Schools that fell into the various classifications are given below:

Experimental-Experimental (EE)

Carter Elementary	Gap Creek
Carter Middle	Ramsey
Copper Ridge	Ritta
East Knox	Vestal

Control-Control (CC)

Blue Grass	Corryton
Brickey	Farragut Primary
Cedar Bluff Primary	Farragut Intermediate
Cedar Bluff Intermediate	Mount Olive

Control-Experimental (CE)

Adrian Burnett	New Hopewell
Bonny Kate	Powell Elementary
Karnes Primary	
Karnes Intermediate	

Experimental-Control (EC)

Ball Camp	Riverdale
Gibbs	Sunnyview
Halls	

(Fairview, High Bluff and White were phased out of the system the second year.)

These groups of schools (EE, CC, EC, and EC) were matched with schools in a comparable suburban area in Tennessee south of Knoxville. The area and the schools are not identified in this report. The matchings of the schools were made by Dr. John R. Ray of the University of Tennessee based upon comparability of achievement levels, socio-economic status, and other related factors of the schools. It was found that reliable matches could only be found for the EE, CC, and CE groups so that the EC group was dropped from further analysis.

Results

In Table I below are given the results of the changes (gains) in grades 2, 3, 4, and 6 of the EE schools (i.e., schools that had both the new curriculum and the traveling mathematics teachers for both 1980-81 and 1981-82) when compared with similar grades in the Control schools. It should be observed that all grades were not available for testing at the Control schools, consequently, the evaluation had to be limited to the grades shown. It should be noted that the curriculum and the traveling mathematics teachers had been in the schools for two years but only one year of gain score was available for analysis. Figure 1 is a graphic presentation of these results.

TABLE I

COMPARISON OF EXPERIMENTAL - EXPERIMENTAL (EE) SCHOOLS OF KNOX COUNTY WITH MATCHED SCHOOLS OF CONTROL GROUP WITH PRE-TEST GIVEN IN SPRING, 1981 AND POST-TEST IN SPRING, 1982*

		KNOX COUNTY			CONTROL GROUP		
		Pre-Test Std. Score Mean	Post-Test Std. Score Mean	Gain	Pre-Test Std. Score Mean	Post-Test Std. Score Mean	Gain
Grade 2***	Math Computation	291.2	339.1	47.9**	298.3	342.6	44.3
	Math Concepts	340.4	382.9	42.5**	342.9	380.9	38.0
	Total Math	327.5	366.5	39.0**	329.9	366.1	36.2
Grade 3	Math Computation	342.1	384.3	42.2	334.4	377.5	43.1**
	Math Concepts	387.8	416.3	28.5**	381.6	394.5	12.9
	Total Math	369.9	401.2	31.3**	363.5	386.8	23.3
Grade 4	Math Computation	383.2	433.0	49.8	390.7	445.6	54.9**
	Math Concepts	417.8	455.8	38.0	404.1	448.1	44.0**
	Total Math	401.4	444.4	43.0	398.5	445.3	44.6**
Grade 6	Math Computation	461.5	502.1	40.6**	479.7	504.6	24.9
	Math Concepts	466.1	500.1	34.0**	476.2	505.3	29.1
	Total Math	463.2	502.6	39.4**	476.0	503.8	27.8

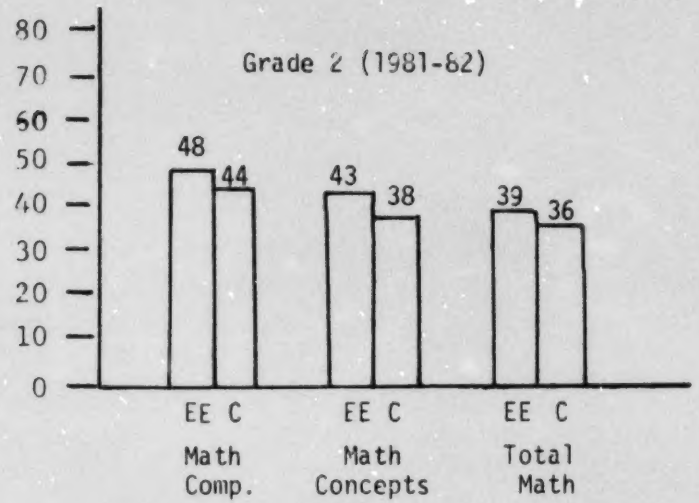
*All scores are from California Achievement Tests

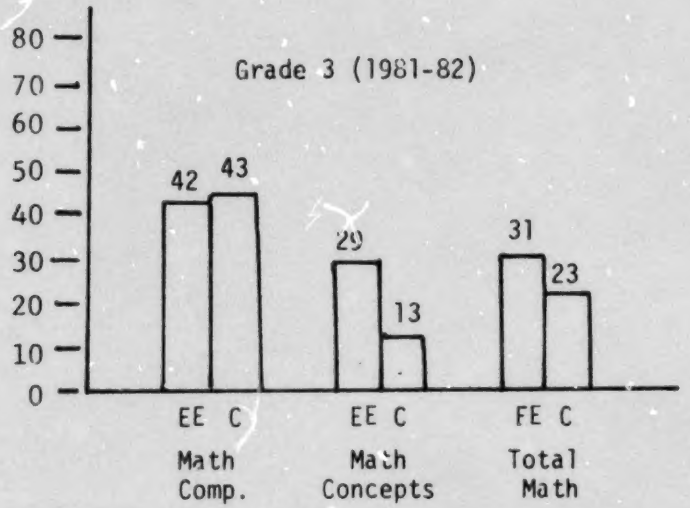
**Represents the greater gain score for the measure indicated

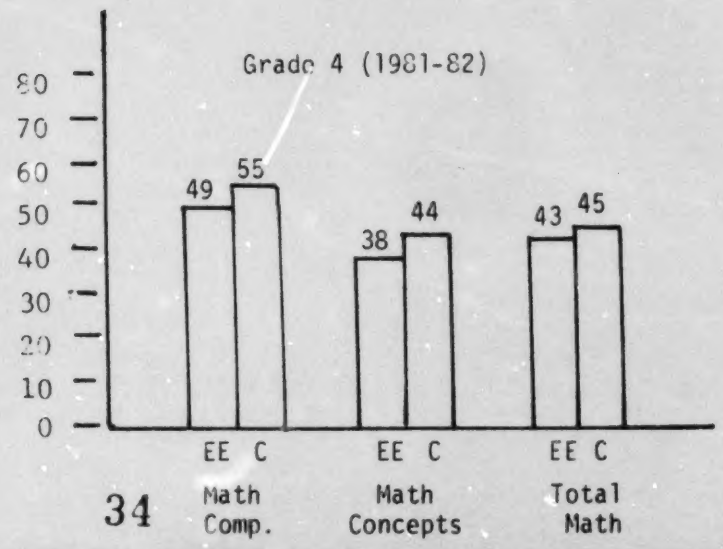
***Grade as of 1981-82

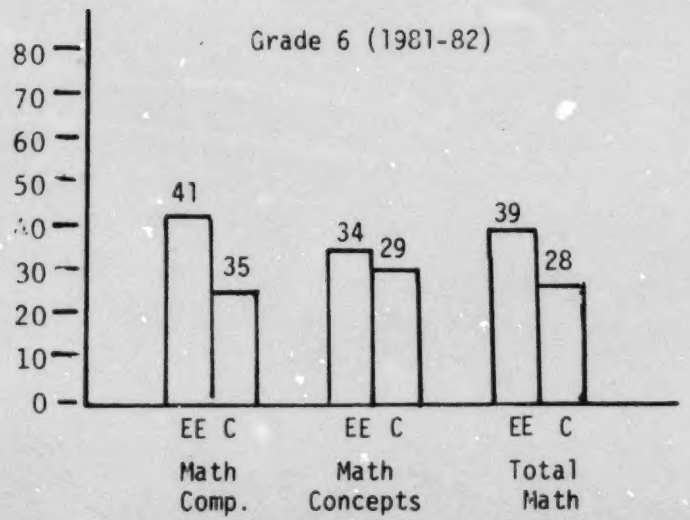
Figure 1

Graphic Comparison of California Achievement Test Results for
Knox County Experimental Schools (EE) and Matched Control Schools,
Spring, 1981 and Spring, 1982









If one reviews the gain scores in Table I. (the fourth and seventh columns), the asterisks indicate those grades in which greater gain scores were achieved for the year. For example, in Knox County EE schools, the mean pre-test score for mathematics computation given in spring of 1981 was 291.2 and a similar mean for spring of 1982 was 339.1 representing a gain of 47.9 units. This gain of 47.9 can be compared with the control schools' gain of 44.3 and seen to be greater. If one reviews all 12 measures (12 possible gains), it can be seen that the Knox County Schools of the EE-Group had greater gains in 8 of the 12 measures or in about 67% of the measures.

In the CE schools, (Table II.) that is, schools which had only the curriculum for both years, it can be seen that the Knox County Schools showed greater gains in seven of nine or 78% of the measures. This appears to be adequate evidence that the curriculum was effective in those three grades when compared with similar grades from the control schools.

Finally, in the CE schools, (Table III.) that is, schools which had the new curriculum for two years and the traveling mathematics teachers for one year (1981-82), it can be seen that greater gains were made in all but three of the measures and those occurred in grade 3. Overall, however, it can be seen that greater gains were found in 67% of the measures in favor of the Knox County Schools in the CE group.

TABLE II

COMPARISON OF CONTROL - CONTROL (CC) SCHOOLS OF KNOX COUNTY

WITH MATCHED SCHOOLS OF CONTROL GROUP

WITH PRE-TEST GIVEN IN SPRING, 1981 AND POST-TEST IN SPRING, 1982*

		KNOX COUNTY			CONTROL GROUP		
		Pre-Test Std. Score Mean	Post-Test Std. Score Mean	Gain	Pre-Test Std. Score Mean	Post-Test Std. Score Mean	Gain
Grade 3***	Math Computation	351.2	409.3	58.1**	350.0	404.2	54.2
	Math Concepts	405.8	441.6	35.8**	400.3	428.8	28.5
	Total Math	382.9	425.4	42.5**	379.4	416.6	37.2
Grade 4	Math Computation	408.2	457.3	49.1	404.9	459.6	54.7**
	Math Concepts	438.3	477.8	39.5**	434.4	472.9	38.5
	Total Math	423.2	467.7	44.5	419.2	465.2	46.0**
Grade 6	Math Computation	459.8	534.3	74.5**	502.7	536.6	33.9
	Math Concepts	473.5	521.5	48.0**	513.9	539.9	26.0
	Total Math	466.3	525.5	59.2**	507.7	537.5	29.8

*All scores are from the California Achievement Tests.
**Represents the greater gain score for the measure indicated.
***Grade as of 1981-82.

Figure 2

Graphic Comparison of California Achievement Test Results for Knox County Control-Control Schools (CC) and Matched Control Schools, Spring, 1981 and Spring, 1982

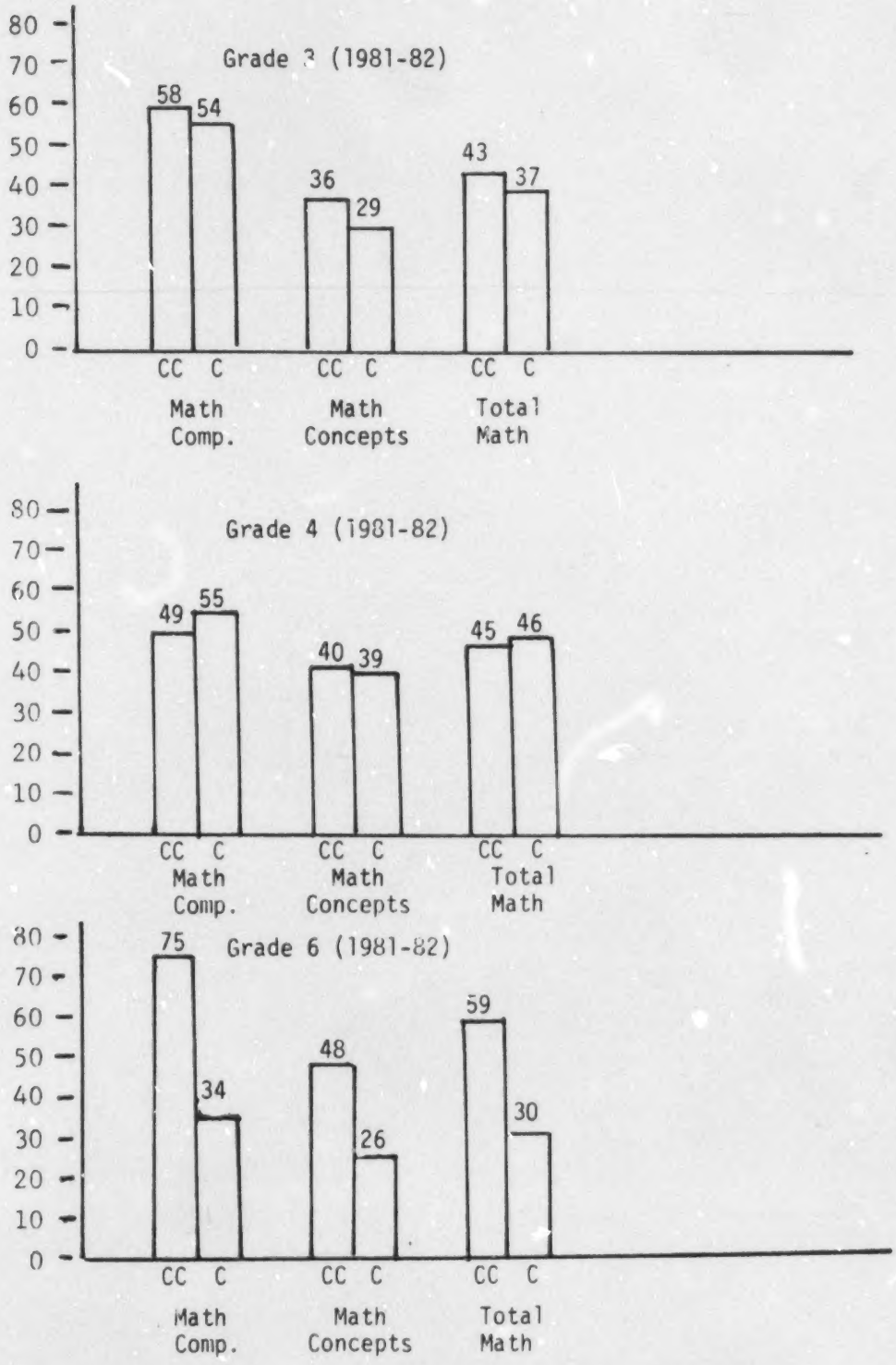


TABLE III

COMPARISON OF CONTROL - EXPERIMENTAL (CE) SCHOOLS OF KNOX COUNTY

WITH MATCHED SCHOOLS OF CONTROL GROUP

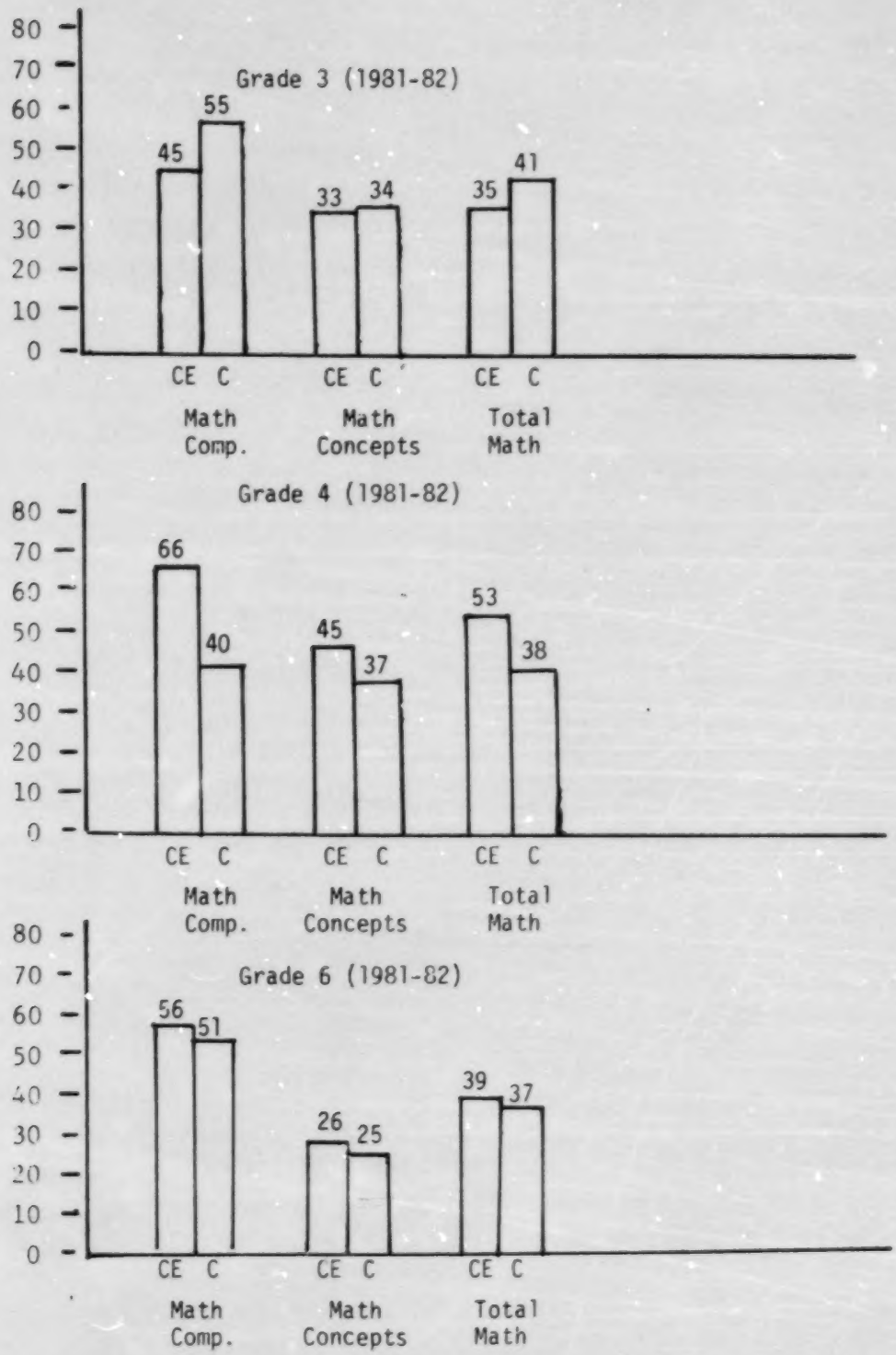
WITH PRE-TEST GIVEN IN SPRING, 1981 AND POST-TEST IN SPRING, 1982 *

		KNOX COUNTY			CONTROL GROUP		
		Pre-Test Std. Score Mean	Post-Test Std. Score Mean	Gain	Pre-Test Std. Score Mean	Post-Test Std. Score Mean	Gain
Grade 3***	Math Computation	342.8	387.4	44.6	350.5	405.1	54.6**
	Math Concepts	391.8	425.1	33.3	390.5	424.6	34.1**
	Total Math	371.9	407.3	35.4	373.8	414.5	40.6**
Grade 4	Math Computation	384.3	450.1	65.8**	413.2	453.6	40.4
	Math Concepts	418.1	463.2	45.1**	435.2	472.2	37.0
	Total Math	402.6	455.7	53.1**	424.0	462.1	38.1
Grade 6	Math Computation	480.5	536.7	56.2**	488.8	539.8	51.0
	Math Concepts	481.5	507.1	25.6**	503.5	528.2	24.7
	Total Math	479.1	518.5	39.4**	494.8	532.1	37.3

*All scores are from the California Achievement Tests
**Represents the greater gain score for the measure indicated.
***Grades as of 1981-82.

Figure 3

Graphic Comparison of California Achievement Test Results for Knox County Control-Experimental (CE) Schools and Matched Control Schools Spring, 1981 and Spring, 1982



Discussion

From reviewing these results, it is apparent that the effect of the traveling mathematics teachers plus the restructured curriculum had very positive effects as revealed by mean gain scores.

Dr. John R. Ray, the UTK evaluator, stated this observation in the following way.

"In the Knox County Mathematics Basic Skills Improvement Program, the influence of the traveling mathematics teachers is a major contributing factor in the program's success. This is especially true when the influence of these staff members is combined with the Knox County mathematics' instructional program. The activities of the traveling mathematics teachers in conducting staff development sessions across the county and in working with individual schools has been a major component in the implementation and success of the mathematics program. ...The influence of the traveling mathematics teachers were felt in three (EE, CE, EC) of the four groups in either 1981 and/or 1982. Thus the results of the program have been influenced through situations in which substantial amounts of instructional support were given classroom teachers by the traveling mathematics teachers, through the sharing of materials, through participation in staff development sessions and in providing general support within buildings."

Comments from Principals

Cold, dry statistics provide one kind of evidence for the evaluation of a program. Such statistics of necessity focus upon results of paper and pencil tests and observational counts. In these tests and counts, much is lost, namely, the opinions of those who are working on the "firing line". Any evaluation would not be complete without the comments of those responsible for the schools, the principals.

In the fall of 1982, an informal request was made of the principals to provide a statement of the most valuable contribution of the project to their schools. Selected comments are provided below:

"Our coordinator, Mrs. Sue Isaac, presented two make-it-take-it" workshops, spent countless hours making materials for teachers, and assisted the classroom teacher in teaching the basic skills. Our second grade CAT for math was 82 percentile. The Title II Math program has created a positive influence in our mathematics curriculum."

Ben Burnett

"I have found the program most helpful. The resource teachers have been able to establish such good working relationships with teachers that when they had suggestions they were heeded. The demonstration teaching by the math resource teachers was a real plus."

Janet Cruze

"The most valuable aspect of the Title II Mathematics project at our school is having the traveling mathematics teacher coming to us on a regular basis. When she comes she is able to help the teachers get needed materials quickly. She is able to help the individual teacher over trouble spots. She also helps the teacher better meet the needs of individual students."

Mayford A. Galyon

"My math teacher was provided the opportunity of taking a special mathematics course through U.T. at no cost to her."

R. B. Gratz

"In the school year 1980-81, Halls Elementary received the help and support of a Title II Math Resource Teacher. During the course of that year, this teacher provided leadership to our math teachers, gave aid whenever it was needed, led us in in-service activities, and, most importantly, provided us with a person who stressed the importance of math in our overall curriculum. As a result, our math scores improved significantly. I believe this program

was a real factor in that improvement and feel that its continuance benefits boys and girls."

Scott Haynes

"I am pleased that we got to keep it (the project) because our children are making improvements on test scores because of it. Emily has worked hard and has been beneficial to our teachers here at Carter Elementary."

Bill Huffaker

"The traveling math resource teachers provide the expertise in math that many principals cannot provide for every subject. The workshops or in-service sessions were very helpful."

J. W. Jones

"Most valuable aspect of project:

1. Guidance in use of Math continuum,
2. Teaching assistance with students needing remediation,
3. The securing of teaching materials,
4. Demonstration in use of new teaching aides

Brenda Latham - Teacher"

James C. King

"The role of the Mathematics Resource teacher was the most stimulating experience for Vestal teachers. An informed, creative, dedicated, yet practical resource person that coordinated and inspired strict adherence to the Math Basic Skills Improvement project."

Leland L. Lyon

"Our program needs have been met in a strong manner as a result of this project. The teachers and students have benefited and became more proficient in their respective areas. Thanks for including our school in this program."

James A. Prince

"The most valuable contribution of the Math Basic Skills Project to our school was the personal type assistance provided the teachers by the resource person. Dictates can emanate and policies may be passed, but consistent follow through will only occur when those implementing the program are involved in daily contact with the teachers responsible for carrying out the changes."

Ron Ross

"It is my pleasure to see such growth in our mathematics program. Mrs. DeRidder and her staff are to be commended. My achievement scores for Karns Intermediate were between 15% and 23% above the national norm. The revised curriculum is certainly a valuable asset to our program, but it has been fully implemented because of our math resource teachers like Mrs. Brenda Latham."

F. H. Russell

"The math skills improvement project provided a valuable liaison person between the math supervisor or the resource teacher, and the local school personnel. The resource person was helpful in explaining changes in material, record keeping, providing hands-on material, sharing of ideas, and continuity of the program between county schools and grade within each school."

James G. Thurman

"The most valuable aspect of the Knox County Mathematics Basic Skills Improvement Project to Powell Elementary has been having a teacher who is a mathematics specialist on a regular basis to demonstrate for teachers the making and use of manipulatives and other materials with students. This has resulted in an increase in the making and use of such by our teachers, and, we think, greater learning."

Fred E. West, Jr.

"The presence of Sandra Hamilton has

1. Improved grouping techniques in math,
2. Teachers' teaching techniques improved,
3. Skill development of students,
4. Better use of teachers editions,
5. Assisted in purchase of additional 'hands-on' materials for staff,
6. Improved curriculum development,
7. Assisted administration in overall math program."

D. K. Wetzel

APPENDIX A

The Curriculum Model

This curricular design is structured to provide a meaningful format for teachers and to address the public concern for basic skill proficiency without sacrificing the breadth and depth of the subject matter of mathematics. With the understanding that this curricular effort will never be completely adequate, but always subject to revision and renewal, there is the security of having a curricular framework which will provide a sense of direction and stability for future work.

The organization of the curriculum can be viewed as three dimensional. First of all, there is the statement of specific skills and concepts to be mastered by students (behavioral objectives). Based on the Knox County mathematics goals and objectives, these skills and concepts include, but are not limited to, the Tennessee State Proficiency Objectives. Enrichment skills are included for all students and advanced skills are included for those students who are more mathematically mature. A unit format, which clusters related skills and concepts, is used for all grades except kindergarten.

Secondly, suggested teaching strategies and learning activities (process objectives) are provided to correspond with the unit skills and concepts for classroom implementation. These strategies and activities have been prepared to reflect the basic skill areas identified by the National Council of Supervisors of Mathematics. The implication is that these process objectives should permeate the teaching/learning activities.

The third dimension of this model is that of assessing student achievement and learning. In constructing the diagnostic/achievement (d/a) inventories for each unit, the attempt has been made to test for the levels of cognition derived from the assessment matrix used by the 1978 National Assessment of Educational Progress, i.e. mathematical knowledge, mathematical skill, mathematical understanding and mathematical application (product objectives). This is true also of the cumulative achievement inventories prepared for grade levels 1-8. Inherent in the unit d/a inventories is a format which assesses mastery of each skill/concept contained within a given unit. (See teacher manual.)

A diagram of this curricular organization has been included for further clarification.

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x Sequential units based on clusters of related skills
y Basic skill areas identified by the NCSM Basic Skills Position Paper
z National Assessment Cognition Levels (NAEP 1978)

KNOX COUNTY MATHEMATICS CURRICULUM

3 dimensional model; grades 1-8
(A curriculum which offers a comprehensive definition of what is "basic" in mathematics.)

z

Mathematical Application (use of knowledge, skill and understanding to solve problems)

Mathematical Understanding

Mathematical Skill

Mathematical Knowledge

Product Objective: Levels of cognition measured by diagnostic/achievement inventories

x Process Objectives: Suggested teaching strategies and learning activities.

y	Problem Solving Techniques	Everyday Applications	Alertness to Reasonableness of results	Estimation and Approximation	Measurement	Tables Charts and Graphs	Using Mathematics to predict	Computer and Calculator Literacy
Numeration and whole numbers grades 1-5 -- Numeration and integers grades 6-8								
Fractions grades 1-5 -- Rational and Irrational numbers grades 6-8								
Geometry and Measurement								

Note: Not every unit will utilize every process objective. The object is to utilize the process objectives as much as possible where appropriate. The implication is that these process objectives should permeate the unit teaching/learning. This is true of measurement activities also, even though there are specific skills in Geometry and Measurement to be taught from the unit dimension.

Behavioral Objectives: Concepts and skills organized by unit -- mastery approach.

KC/1980
Charleen DeRidder

Implementation Rationale

Current research indicates that approximately 6% of the students in U.S. schools apparently suffer from development dyscalculia.[1] These are well motivated children who have normal intelligence yet evidence disability in arithmetic. There is also a substantial percentage of students who are poorly motivated, others who have experienced instructional gaps in the learning process, and still others who are identified as having more general mental difficulties. All of these students constitute a major element of the typical student group challenging each elementary and middle school teacher. However, both current research and the conventional wisdom of the experienced teacher indicate that most of these children, while operating at one or more grade levels below normal, exhibit kinds of errors and difficulties similar to those of younger children.

For this reason, it is extremely important that all students be assessed to determine their level of achievement and provided cognitive entry into the curriculum at a level commensurate with their developmental stage of learning. In light of the conventional placement of students within public schools, this means that the teacher, to be effective, will need to group students within a given class to provide appropriate learning experiences for all students. Such grouping should allow for flexibility and be accomplished periodically, depending on the topics of instruction. Initial assessment of student achievement can be done using the diagnostic inventory for a given grade, scanning the Mathematics Pupil Progress Record, and consideration of any other student information provided by the student cumulative record. Unit diagnostic/achievement inventories also may be used as pre-tests before starting a particular unit. These inventories reveal exactly the skill areas of student mastery or deficiency, which in turn can determine the organization of instruction for students with a given class.

While there is some latitude concerning which units and/or skills can be introduced first, there is still a certain degree of sequentiality in the structure of mathematics which cannot be ignored. Even though at times students are capable of intuitive leaps of comprehension which span the sequence of several skills, there is no substitute for thorough understanding and the internalization of basic concepts.

The question is, what is the implication of all this for the teacher? Consider a sixth grade class where ten students exhibit the achievement level in fractions of fifth graders, fifteen students are on grade level, and five others are ready for upper sixth grade or beginning seventh grade work. To provide meaningful and relevant instruction, the teacher would be advised to provide instruction based on fraction units from the curriculum which correspond to the student needs. By using the suggested materials and rotating time with the different groups, the teacher should be able to provide students the opportunity

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[1] M.L. Weinstein, "Dyscalculia: A Psychological and Neurological Approach to Learning Disabilities in School Children: (Ph. D. diss., University of Pennsylvania, 1978)

to be successful at the appropriate instructional level. It is helpful to keep in mind that student difficulty is so often one of developmental [illegible] mentally, but not an incurable malaise. A sixth grade teacher simply has to work as a fourth or fifth grade teacher to assist students to grow and to acquire more mature techniques with computational algorithms and problem solving.

Benjamin Bloom[2], on the basis of years of study and research, states that over 90% of our students can achieve the objectives being asked of them in schools. The important thing is to determine their level of cognitive entry into the curricular content and provide meaningful instruction. Teacher-student interaction is a major component in the determination of student success in a given subject.

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[2]Bloom, Benjamin S. Human Characteristics and School Learning (New York: McGraw-Hill, 1976)

Current Textbook Adoption in Mathematics for Knox County (1982)
For Grades K-8

Bitter, Gary G., Max A. Sobel, et al. McGraw-Hill Mathematics. New York: Webster Division, McGraw Hill, Inc. 1981.

APPENDIX B

Knox County Mathematics Curriculum

Third Grade

NUMERATION AND WHOLE NUMBERS

Unit I:	Numeration	1-11
Unit II:	Addition and Subtraction	12-16
Unit III:	Numeration to Thousands	17-22
Unit IV:	Addition and Subtraction	23-28
Unit V:	Introduction to Multiplication and Division .	29-38
Unit VI:	Multiplication and Division	39-42

FRACTIONS AND DECIMALS

Unit VII:	Fractions	43-48

GEOMETRY AND MEASUREMENT

Unit VIII:	Time	49-52
Unit IX:	Measurement	53-58
Unit X:	Geometry	59-62

Possible
Teaching Strategies/Learning Activities

Skill 1

(a) Introduce using Cuisenaire Powers of Ten Set (or similar manipulatives).

(b) Use place value and expanded notation to help students understand the process of multiplying the ones by the multiplier and the tens by the multiplier.

example: $23 \rightarrow 20 + 3 \rightarrow 20 \times 3 = 60$ + $3 \times 3 = 9$ $\rightarrow 60 + 9 = 69$

"short" method: $23 \times 3 = 69$

Be sure the concept is understood before the "short" method is used.

Skill 2

(a) Introduce using Cuisenaire Powers of Ten Set (or similar manipulatives) and emphasize the need to regroup ones into tens and ones.

(b) Use place value and expanded notation.

example: $23 \rightarrow 20 + 3 \rightarrow 20 \times 4 = 80$ + $3 \times 4 = 12$ $\rightarrow 80 + 12 = 92$

"short" method: $23 \times 4 = 92$

Be sure the concept is understood before the "short" method is used.

Skill 3

(a) Spectrum Mathematics - Workbook (red)

(b) Have upper grade students write simple word problems for third graders to do.

(c) Calculators

(d) Problem Solving with the Calculator - Use with regular calculators. (Grade 2 - 6)

Skill a4

(a) Use Cuisenaire Powers of Ten Set

(b) Use concrete media for grouping

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NUMERATION & WHOLE NUMBERS	Unit VI: Multiplication and Division	McGraw-Hill	Macmillan	Grade 3 Page 40 Random House
	The vocabulary list for Unit VI: multiply divide digit divisor quotient dividend			
1.	The student multiplies a two-digit number by a one-digit number without regrouping (trading).	318-323	290-295	201-203
2.	The student multiplies a two-digit number by a one-digit number with regrouping.	324-325	296-298	200-204
3.	The student solves one-step word problems using skills previously learned.	149, 157-159, 219, 227-229, 232-233	137 200-201	------
a4.	The student divides a one-digit divisor into two-digit dividends up to 100 with remainders.	254-255, 328-337	189-197	-----

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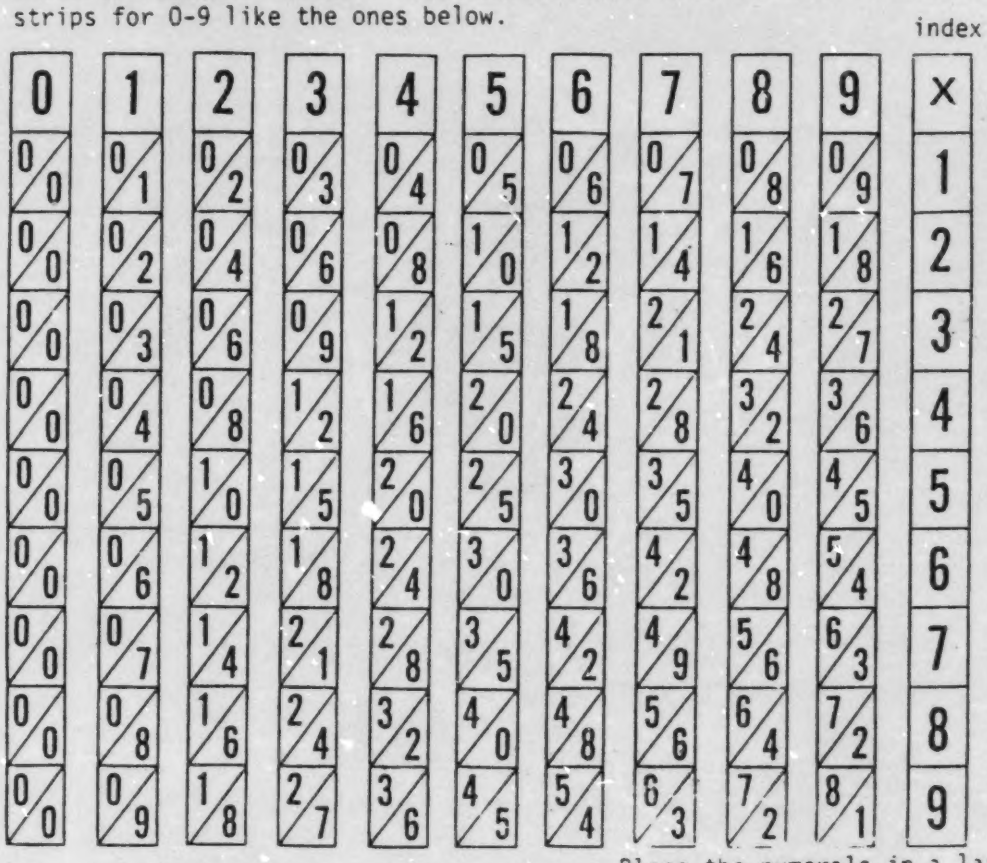
Grade 3 Page 41 NUMERATION & WHOLE NUMBERS	Unit VI: Multiplication and Division	McGraw-Hill	Macmillan	Random House
	a5. The student multiplies a two-digit number by a two-digit number without and with regrouping.	---	---	---

Possible
Teaching Strategies/Learning Activities

Skill a5

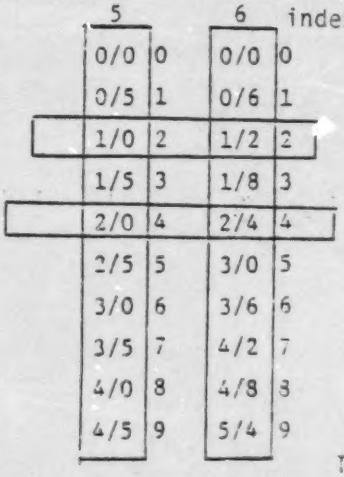
Napier's Bones were used in the middle ages to compute since the common people did not know their multiplication facts. Each "bone" is really just a list of the multiples of the number at the top of the "bone." These bones can be made from flat wooden rods painted white to resemble "bones." Posterboard could also be used. Make strips for 0-9 like the ones below.



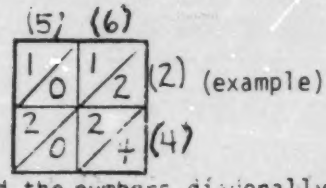
To multiply

56
x24

→

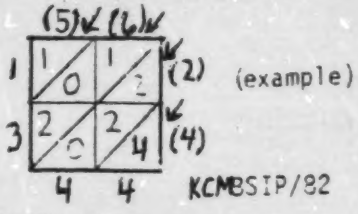


Place the numerals in a lattice...



(example)

then add the numbers diagonally.



(example)

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The answer is 1344.

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Grade 3 UNIT VI Test

Multiplication

Name_____

Date_____

Score_____

Skill 1

Find the product.

Number Correct

(1) 24 X2

(2) 13 X3

(3) 32 X3

(4) 12 X4

3 of 4

Skill 2

(5) 45 X3

(6) 34 X4

(7) 57 X5

(8) 68 X2

3 of 4

Skill 3

(9) Mark and Ellen each have 16 pieces of construction paper for an art project. How many pieces of paper do they have in all?

_____

(10) Kathy bought 4 boxes of tomato plants with 6 plants in each box. How many tomato plants did Kathy buy?

_____

Grade 3 Unit VI Test Name_____

Number Correct

Skill 3 (continued)

(11) Mrs. Brown bought hot dogs for her children. Each child ate 2 hot dogs. If she has 4 children, how many hot dogs did the children eat?

_____

(12) Jessica bought 5 bags of marbles. Each bag contained 23 marbles. How many marbles did Jessica buy altogether?

_____

3 of 4

10 ITEM TEST

Name_____

UNIT VI: Multiplication

SKILL 2

Date_____

Grade 3

Score_____

Find the product.

(1) 44
X 3

(2) 35
X 4

(3) 82
X 5

(4) 63
X 5

(5) 78
X 2

(6) 96
X 3

(7) 28
X 4

(8) 54
X 4

(9) 36
X 2

(10) 49
X 3

KNOX COUNTY MATHEMATICS PUPIL PROGRESS RECORD

Name _____

Grade ⊘ introduced X ● mastered

Grades 1-4: mn unit test percent score; n skill not mastered; ✓ skill mastered

example: 75 5 ; 75 ✓

Enrichment or Advanced Activities ☒

Facts Test Mastery ☒

KINDERGARTEN

- ○ 1. Determines comparison of size, height, length, etc.
- ○ 2. Matches shapes
- ○ 3. Classifies objects into sets
- ○ 4. Identifies coins
- ○ 5. Indicates smaller set when element is removed
- ○ 6. Indicates larger set when element is added
- 7. Explores geometric solids (Enrich.)
- ○ 8. Recognizes measurement instruments and their uses
- ○ 9. Divides real objects in half
- ○ 10. Recognizes and continues patterns
- ○ 11. Identifies shapes
- ○ 12. Names shapes
- 13. Begins development of conservation of number (Enrich.)
- ○ 14. Constructs equivalent sets by one-to-one correspondence
- ○ 15. Counts orally from 1 to 5
- 16. Identifies cardinal numbers of a set 0-5
  - a. by counting ○
  - b. on sight ○
- ○ a17. Counts ordinally from first to fifth
- ○ 18. Identifies which of two sets is more or less (to 10)
- ○ 19. Orders 3 sets or pictured sets
- ○ 20. Counts orally 1-10 (advanced to 12)
- ○ 21. Identifies cardinal number of set 0-10 (advanced to 12)
- ○ 22. Uses a specific unit for comparison in measurement
- ○ a23. Divides a set of real objects in half
- 24. Identifies and matches numerals to sets (0-10)
  - a. 0-5 ○
  - b. 6-10 ○
  - c. 11,12 (advanced) ○
- ○ 25. Puts numerals in order from 0-10 (advanced to 12)
- ○ a26. Places numerals on clock face in order from 1 to 12
- ○ a27. Identifies the meaning of clock hands
- ○ a28. Reads time on the hour
- ○ 29. Divides picture of real object in half
- ○ 30. Copies shapes
- ○ a31. Uses number line to find distances
- ○ a32. Measures perimeter using nonstandard units
- ○ a33. Finds area using nonstandard units
- ○ a34. Begins development of concept of addition
- ○ a35. Begins development of concept of subtraction
- ○ a36. Uses and makes simple graphs and charts

Topics	Units Grade 1	Evaluation	Units Grade 2	Evaluation	Units Grade 3	Evaluation	Units Grade 4	Evaluation
NUMERATION AND WHOLE NUMBERS	I Working with Numbers 0-10 II Addition and Subtraction 0-10 III Working with Numbers 0-100 IV Addition and Subtraction 0-100		I Addition and Subtraction II Addition and Subtraction III Numeration IV Addition and Subtraction		I Numeration I Addition and Subtraction Addition Facts Subtraction Facts III Numeration to Thousands IV Addition and Subtraction V Introduction to Multiplication and Division Multiplication Facts Division Facts VI Multiplication and Division		I Addition and Subtraction II Numeration III Multiplication Multiplication Facts IV Division Division Facts	
	Enrich. Adv.		Enrich. Adv.		Enrich. Adv.		Enrich. Adv.	
FRACTIONS	V Working with Fractions		V Fractions		VII Fractions		V Fractions VI Addition and Subtraction of Fractions VII Money and Decimals	
	Enrich. Adv.		Enrich. Adv.		Enrich. Adv.		Enrich. Adv.	
GEOMETRY AND MEASUREMENT	VI Working with Time VII Working with Measurement VIII Working with Shapes		VI Geometry VII Measurement VIII Money IX Time		VIII Time IX Measurement X Geometry		VIII Time IX Measurement X Geometry XI Graphs	
	Enrich. Adv.		Enrich. Adv.		Enrich. Adv.		Enrich. Adv.	
ASSESSMENT	Placement Test Cumulative Achievement Inventory Teacher _____		Placement Test Cumulative Achievement Inventory Teacher _____		Placement Test Cumulative Achievement Inventory Teacher _____		Placement Test Cumulative Achievement Inventory Teacher _____	

64

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63

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46

KNOX COUNTY MATHEMATICS PUPIL PROGRESS RECORD

Name _____

Grades 5-8

nn unit test percent score
n skill not mastered
✓ objective mastered

example: 75 5 ; 75 ✓

Enrichment or Advanced Activities [X]

Facts Test Mastery [X]

	Units	Grade 5	Evaluation	Units	Grade 6	Evaluation	Units	Grade 7	Evaluation	Units	Grade 8	Evaluation
NUMERATION AND INTEGERS	I	Addition and Subtraction		I	Addition and Subtraction of Integers		I	Whole Number Operations		I	Numeration	
	II	Multiplication of Whole Numbers		II	Multiplication and Division		II	Place Value and Number Systems		II	Operations and Applications of Integers	
		Multiplication Facts		III	Numeration		III	Integers		III	Exponents and Their Applications	
	III	Division of Whole Numbers		Enrich.		Adv	Enrich.		Adv	Enrich.		Adv
		Division Facts		IV	Fraction Introductory Unit		IV	Fraction Skills Introduction		IV	Decimals: Operations and Applications	
	IV	Numeration		V	Addition and Subtraction of Fractions		V	Addition and Subtraction of Fractions		V	Rationals: Operations and Applications	
RATIONAL AND IRRATIONAL NUMBERS	Enrich.		Adv	VI	Multiplication and Division of Fractions		VI	Multiplication and Division of Fractions		VI	Percent: Operations and Applications	
	V	Introduction to Fractions		VII	Addition and Subtraction of Decimals		VII	Introduction to Decimals		VII	Advanced Unit: Equations and Inequalities	
	VI	Operations with Fractions I		VIII	Multiplication and Division of Decimals		VIII	Decimal Operations		VIII	Usage of Graphs	
	VII	Operations with Fractions II		IX	Introduction to Percent		IX	Introduction to Percent		Enrich.		Adv
	VIII	Decimals		Enrich.		Adv	X	Percent Applications		IX	Applications of the Customary and Metric Systems	
	Enrich.		Adv	X	Understanding Units of Measure		Enrich.		Adv	X	Applications of Basic Terminology in Geometry	
GEOMETRY AND MEASUREMENT	IX	Measurement		XI	Measurement and Application		XI	Measurement		XI	Applications of Formulas, Algorithms and Theories	
	X	Geometry		Enrich.		Adv	XII	Geometry		XII	Drawing and Construction	
	Enrich.		Adv				XIII	Statistics		Enrich.		Adv
							Enrich.		Adv			
ASSESSMENT		Placement Test			Placement Test			Placement Test			Placement Test	
		Cumulative Achievement Inventory			Cumulative Achievement Inventory			Cumulative Achievement Inventory			Orleans-Hannah Algebra Prognosis Test	
											Basic Skills Diagnostic Test	
	Teacher _____			Teacher _____			Teacher _____			Teacher _____		

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APPENDIX C

SCHOOLS SERVED	PRINCIPALS
1980-81 – Fairview	Fred Russell
– Halls Elementary	Scott Haynes
– Gibbs Elementary	Jim Thurman
– Riverdale	Lee Vittetoe
– High Bluff	Jan Cruze
– White	Charles Cameron
– Ball Camp	Andy Shockley
– Sunnyview	William Thomas
1980-82 – Carter Elementary	William Huffaker
– Carter Middle	Harry Whitt/Robert Gratz
– Copper Ridge	Ray Ross
– East Knox County	David Wetzel
– Gap Creek	James King
– Ramsey	Judy Pressnell/Jan Cruze
– Ritta	J. W. Jones
– Vestal	Ben Burnette/Leland Lyon
1981-82 – Adrian Burnett	James Prince
– Bonny Kate	Lewis Robinette
– Karns Primary	Ben Burnette
– Karns Intermediate	Fred Russell
– New Hopewell	Mayford Galyon
– Powell Elementary	Fred West

PROJECT EVALUATION

Directed by Dr. John Ray, UTK
Bureau of Education Research and Service

Assisted by Dr. Sam Bratton
Knox County Research Supervisor

PROJECT STAFF

Director
Charleen DeRidder,
Mathematics Supervisor

Advisor
Dr. Donald J. Dessart,
University of Tennessee

TRAVELING MATHEMATICS TEACHERS

Linda Fidler	Sandra Hamilton
Sue Isaac	Kathy Arnold 1980-81
Brenda Latham	Emily Lenn 1981-82

Knox County
MATHEMATICS
Basic Skills Improvement Project
P. O. Box 2188
Knoxville, Tennessee
37901-2188

Knox County

MATHEMATICS BASIC SKILLS IMPROVEMENT PROGRAM

A demonstration project funded by
The Title II Basic Skills Improvement Program
U. S. Department of Education

KNOX COUNTY SCHOOLS
Earl Hoffmeister, Superintendent
Sarah Simpson, Acting Director of Instruction

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PURPOSE

TO IMPROVE STUDENT PERFORMANCE IN MATHEMATICS, GRADES K-8, BY A CURRICULAR PROGRAM THAT:

Assesses student achievement levels

Provides meaningful learning

Includes problem solving that goes beyond basic computational skills.

PROGRAM

FIVE TRAVELING MATHEMATICS TEACHERS PROVIDE MANY NEEDED SERVICES

Meeting with Principals and parents

Working with teachers

Elementary Supervisors

Presenting inservice sessions

Doing demonstration lessons

Working with special education teachers

Meeting with central office staff

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APPENDIX D

TEACHING

Using a Directed Lesson

By **Charleen DeRidder**
and **Donald J. Dessart**

What does a teacher do to guide students in the development of specific mathematical skills? In this article we outline five steps—*introducing*, *presenting*, *analyzing*, *practicing*, and *applying*—that are designed to help teach a directed mathematics lesson.

Introducing

The introduction of a skill consists of two parts: looking back and looking ahead. In looking back, the teacher helps the student recall previous learnings that are necessary for learning the new skill. This is a matter of preparing the student's mind for what is coming next. In looking ahead, the teacher offers motivation for what is coming next.

A skill can be introduced in a variety of ways. For example, students can be asked questions that recall concepts or facts they have already learned but need to review. Tangible materials such as place-value blocks or Cuisenaire rods, can be used to reconstruct past experiences. Audio-visual materials can be used as a review to refresh student's previous learnings. Selected games and activities can be excellent means of recall of skills necessary to the learning of the new skills that are to be presented.

Presenting

In the presentation stage, it is important that the teacher has analyzed the skill into its subskills so that each can be taught. For example, in the addition of fractions with unlike denominators, finding least common denominators, writing other names for the fractions so the denominators are the same, and adding fractions with like denominators are some of the subskills that are to be presented. Finally, of course, the subskills must be incorporated into the total skill so that the student can, in fact, add two or more fractions with unlike denominators.

To accomplish the "presenting" of a new skill, a variety of methods and media can be used. Schminke, Maertens, and Arnold (1973) suggest such techniques as exposition (explaining an idea), illustration (visual presentation of an idea), demonstration (showing a way of doing something), discussion (inquiry-response interaction between teacher and students) and exploration (encouraging students to discover or observe relationships) as ways of presenting. The chalkboard, overhead projector, audio-visual media and/or manipulative materials can be used in the presentation of the skill.

Analyzing

Analysis of the level of student's acquisition of the skill is very important at this stage of a directed lesson. Do the students have sufficient command of the concepts, principles, or previous skills necessary for mastery of the new skill? Before students are guided into the practicing step, teachers need to offer sample exercises or ask carefully prepared questions to insure student understanding of what has been taught. Why assign twenty exercises to be done if the children do not understand what they are doing and "why"? Doing work incorrectly because of misunderstanding creates the need for remediation—a task with which teachers are already burdened. The immediate doing and checking of three to five exercises allows the teacher to observe student work and catch possible misconceptions or lack of understanding before the practice assignment is given. If misunderstandings are evident, new material should be "re-presented" in a different way to clarify the problem situation.

Although "analyzing" is stated as the third step in the procedure of the directed lesson, it can be thought of as an attitude or teaching behavior that should permeate the total instructional process. For example, when a teacher begins the school year with a class, student performance in mathematics needs to be analyzed to determine achievement levels. Usually this is accomplished by some form of test after a brief review of previous work. This kind of analysis can provide guidelines for the development of instructional plans appropriate for student learning.

Analysis also occurs when the teacher examines the results of student's assignments and tests. This kind of analysis can be thought of at two different levels:

1. Analysis of computational errors and error patterns.
2. Analysis of student performance of skill application or problem solving.

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The purpose of both, however, is to provide the focus for corrective instruction. Too often student work is merely scored and recorded, when it should be analyzed.

Practicing

Practice reinforces the acquisition of skills. At one time in the history of mathematics education, "drill" became a very unpopular word. Compulsive, rote drill is still not desirable, but meaningful, directed drill is necessary. Drill should follow "meaningful instruction"—just practicing "mathematics" by doing many exercises is highly inappropriate.

Drill can be accomplished in a variety of ways. We usually think of drill as involving exercise sheets or homework assignments. Although these are important drill activities, they are not the only ways by which drill and practice can be done. Teachers have found games a convenient tool for drill. Peer drill, in which a student works with a classmate using flash cards or other drill materials or activities, has also been found very useful.

A lengthy discussion of the many ramifications of drill or practice is not possible in this short paper, but questions about the pacing of drill and the distribution of drill have concerned mathematics educators for a long time (Dessart 1982). In general, it has been found that shorter episodes of drill spread over a period of time are more effective than drill massed into one period.

Applying

After a teacher has introduced a skill, presented it, analyzed the students' difficulties, and had the students practice the skill, he or she is ready to have the students apply the skill. The teacher provides opportunities not only for using the particular skill that has been learned, but also for applying a variety of other skills that have been previously learned. "Applying" is critical to mathematical learning. It is the primary reason for the development of skills.

"Applying" can be considered at two different levels: that of "simple application" and that of "true problem solving." Simple application might well be placed in the category of practicing except that students are required to do more than just perform an algorithm. For example, after studying how to determine the volume of certain geometric solids, a student may be given a problem: "At 20° C, how many liters of water does a cylindrical tank with a diameter of 8 meters and a height of 15 meters hold?" The student needs to determine what the problem asks, select the appropriate formula, and compute the results. In other words, he or she must "set up" or reformulate the problem. Once a student realizes how to compute the result for a particular kind of written problem, however, it may no longer be a problem; it becomes merely an exercise. This type of applying can be thought of as work with routine problems.

Work with nonroutine problems is "applying" in its truest and highest sense. It is a process that has far-reaching implications for not only mathematics but also many fields of endeavor. The popular model for nonroutine problem solving that has received attention in recent years is that developed by Polya (1957). In the Polya model, emphasis is placed on the phases of problem solving. It is not an algorithm for solving problems but rather a framework in which a student's problem-solving abilities can be nurtured.

The broad steps of the Polya model which have been stated in many different ways by various people are as follows:

1. Understand the problem.
2. Devise a plan.
3. Carry out the plan.
4. Look back.

The teacher can use this model in working with a class. As is frequently the case, many students will wish to jump immediately to step 3, "Carry out the plan," before giving attention to steps 1 and 2. It is the teacher's role to guide the students through all phases of problem solving to insure the develpment of good problem-solving habits.

Conclusion

To teach a directed lesson means to help students master specific mathematical skills, as well as to formulate concepts and understand principles. We have suggested five steps to be followed *introducing, presenting, analyzing, practicing* and *applying*. The application of these steps to the teaching process gives a clear focus to the lesson being taught.

References

Dessart, Donald J. "Begle Memorial Series on Research in Mathematics Education: The Variable of Drill Revisited." Marilyn Zweng, ed. In *Proceedings of the Fourth International Congress on Mathematical Education*. Boston: Birkhauser Boston, 1982.

Polya, George. *How to Solve It*. New York: Doubleday and Company, Inc., 1957.

Schminke, C. W., N. Maertens, W. Arnold. *Teaching the Child Mathematics*. Hinsdale, Ill.: The Dryden Press, Inc., 1973.

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32